Curved Post-Tensioned Bridges

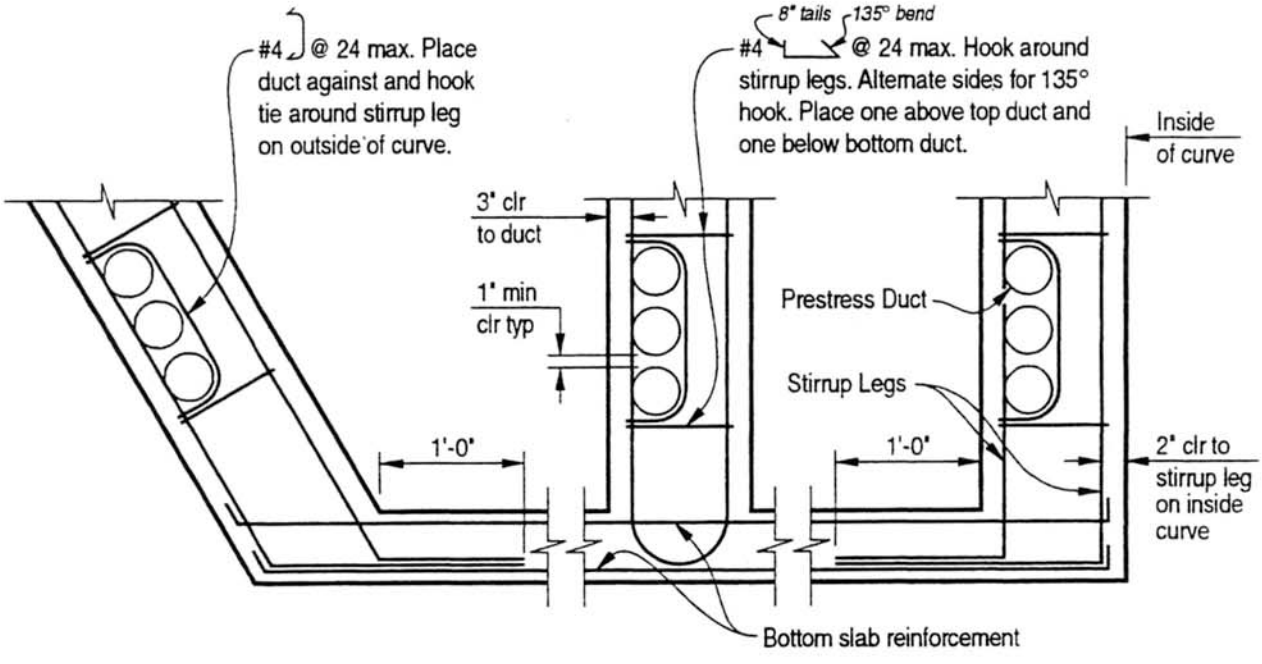
Designers should consider the lateral prestress force on any curved post-tensioned structure. Calculate this force (F) for each girder, by dividing the jacking force (P_j) per girder by the horizontal radius (R) of the girder.

All girders with a $P_j/R > 7$ k/ft. per girder or a horizontal radius (R) of 800' or less shall use Detail "A" shown on page 2 of this memo.

The included graphs may be used to check girder webs for containment of tendons and adequate stirrup reinforcement to resist flexural bending.

The last section of this memo provides a commentary on design assumptions.

Supersedes Memo to Designers 11-31 dated September 1985

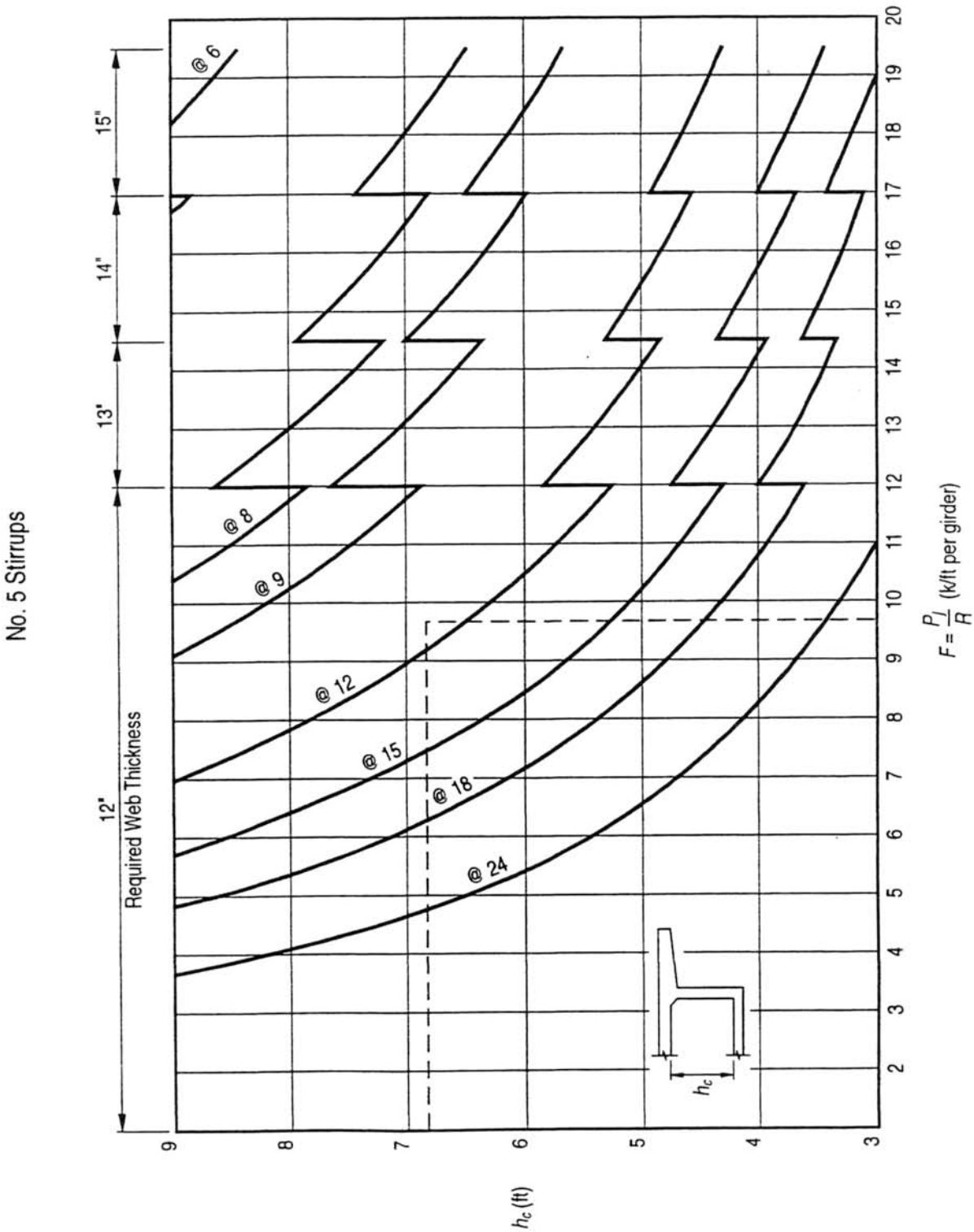


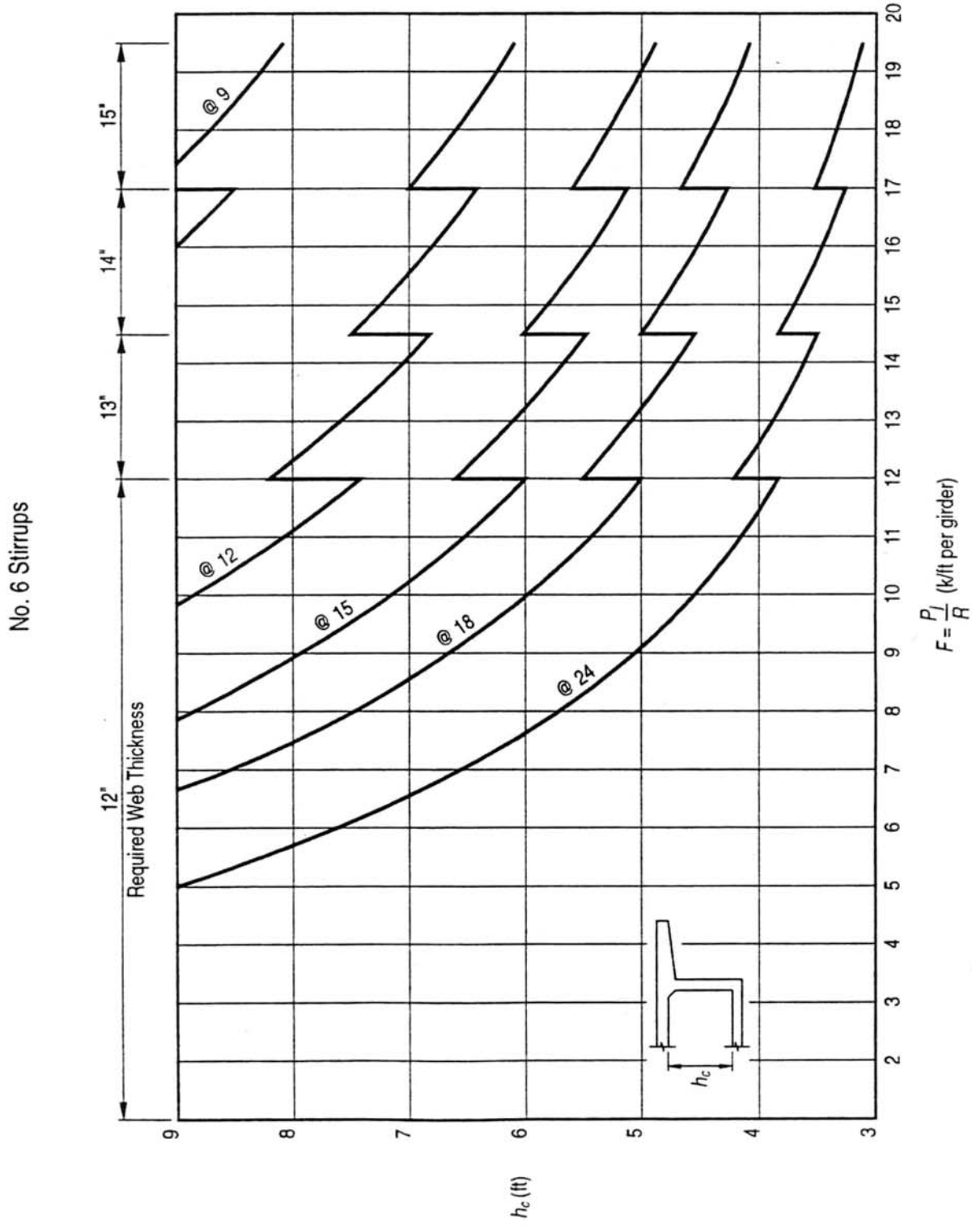
Note: Details shown are for a curve to the right with the section taken looking ahead on station. These details supersede duct patterns shown in Standard Plan B8-5.

PART GIRDER SECTION

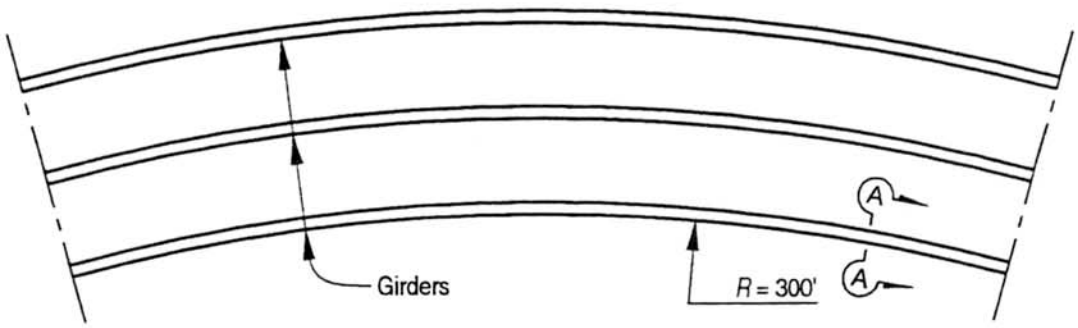
Detail "A"

Use of Detail "A" will require an adjustment of the basic prestressing steel path ordinates used for design. See Memo to Designers 11-28.

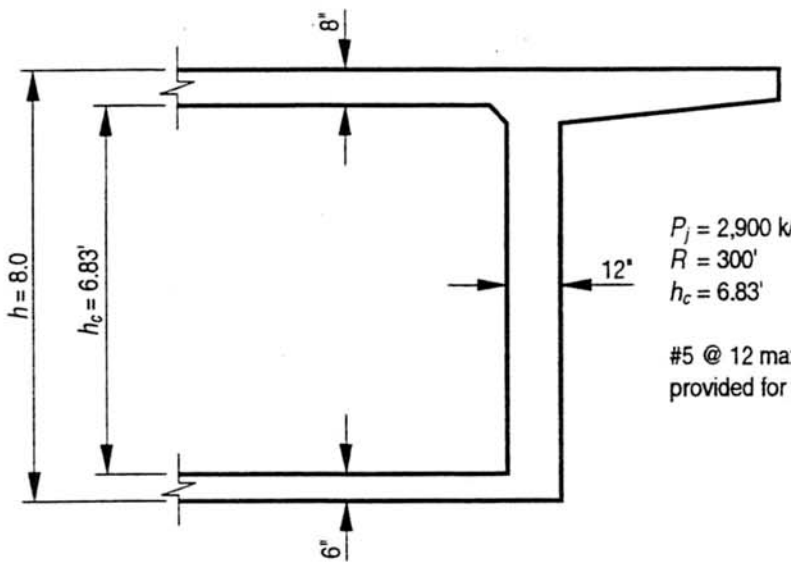

No. 5 Stirrups
15"
14"
13'
12'
Required Web Thickness
@ 6
@ 8
@ 9
@ 12
@ 15
@ 18
@ 24
h_c
h_c (ft)
$F = \frac{P_J}{R}$ (k/ft per girder)
9
8
7
6
5
4
3
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20


No. 6 Stirrups
15"
14"
13"
12"
Required Web Thickness
@ 9
@ 12
@ 15
@ 18
@ 24
h_c
h_c (ft)
$F = \frac{P_I}{R}$ (k/ft per girder)
9
8
7
6
5
4
3
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20

Example



PLAN



SECTION A-A

$$F = P_j/R = 2{,}900/300 = 9.67 \text{ k/ft}$$

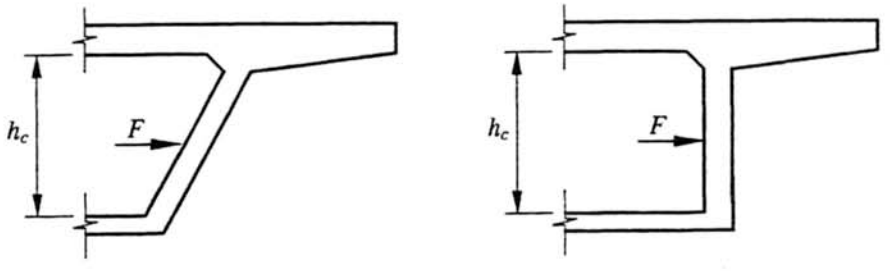
From the graph for No. 5 Stirrups, $F = 9.67$ and $h_c = 6.83$ —decrease maximum stirrup spacing from 12" to 9".

Commentary

The following assumptions were made in the development of this Memo to Designers:

Bending Moment

The girder web is assumed to be a beam with a length equal to the clear distance between top and bottom slabs (h_c). The lateral prestress force (F) is acting at the center point of the web ($h_c/2$). The moment is calculated by simple beam formula reduced 20% for continuity between web and slabs with 1.0 load factor applied.



$$M_u = (1.0)(0.8)(1/4)(P_j/R)(h_c) = 0.20\ (F)\ h_c$$

The shear and bending stresses in the girder stirrups are additive. For the purposes of this memo, however, stirrups are considered capable of handling these stresses independently for the following reasons:

- M_u is calculated for the maximum condition of F acting at $h_c/2$. This occurs at only two points in a span due to tendon drape.
- The jacking force, P_j, is used in the calculation of M_u, and at the time P_j is applied, the structures is supported on falsework. When the falsework is removed and vertical shear forces act, the prestressing force has been reduced by losses.

Floyd L. Mellon

Jerry A. McKee

EKT:jgf

11-31 CURVED POST-TENSIONED BRIDGES

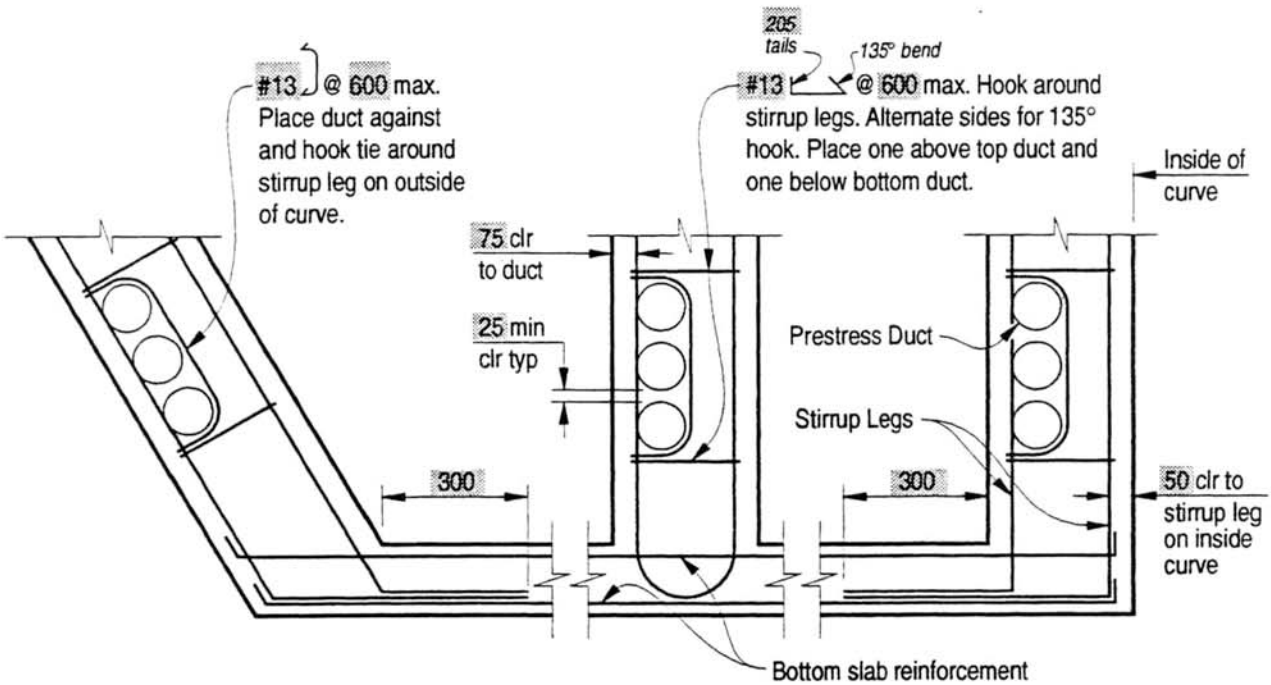
Designers should consider the lateral prestress force on any curved post-tensioned structure. Calculate this force (F) for each girder, by dividing the jacking force (P_j) per girder by the horizontal radius (R) of the girder.

All girders with a $P_j/R > 100$ kN per m per girder or a horizontal radius (R) of 250 m or less shall use Detail "A" shown on page 2 of this memo.

The included graphs may be used to check girder webs for containment of tendons and adequate stirrup reinforcement to resist flexural bending.

The last section of this memo provides a commentary on design assumptions.

Memo converted to metric.

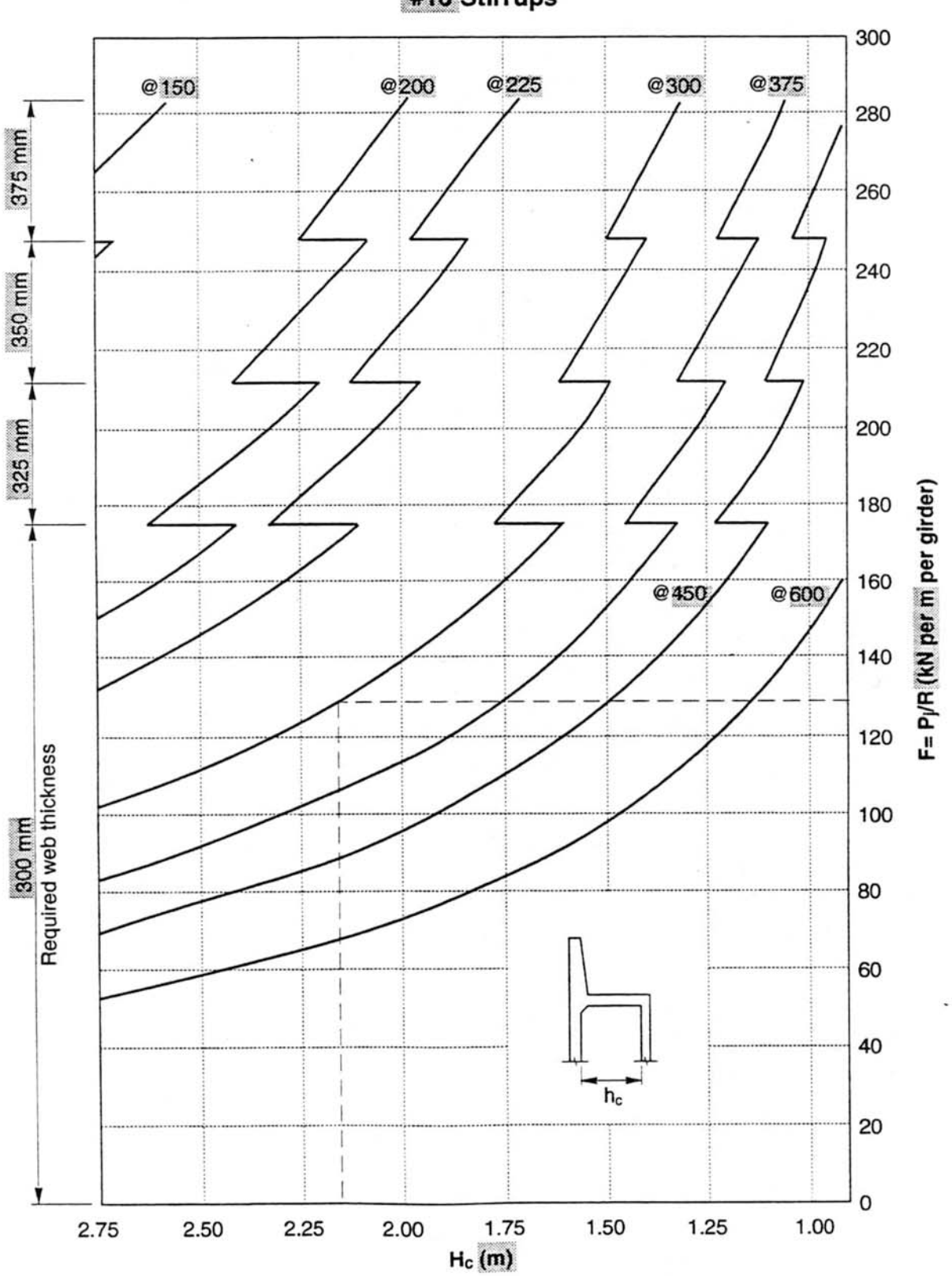


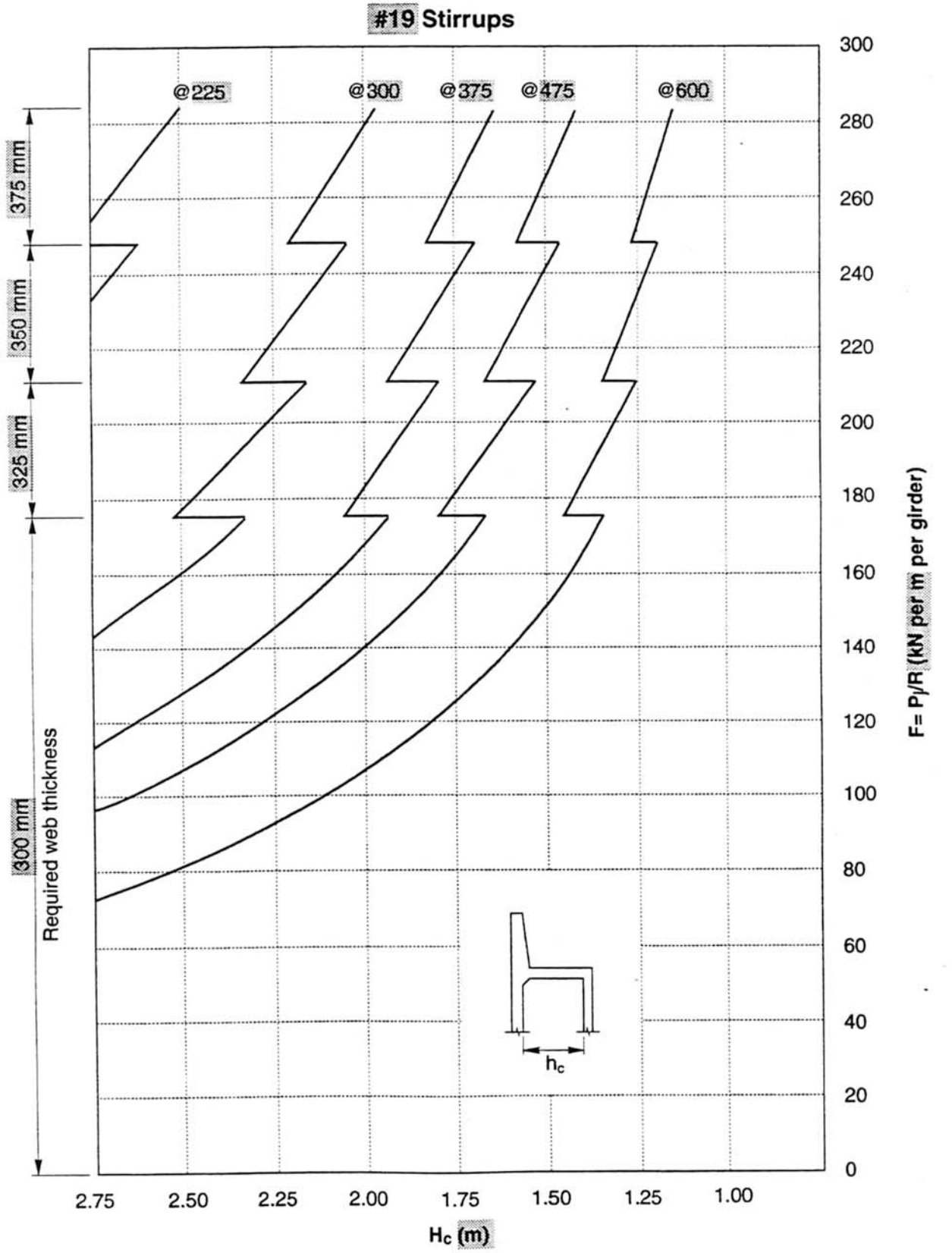
Note: Details shown are for a curve to the right with the section taken looking ahead on station. These details supersede duct patterns shown in Standard Plan B8-5.

PART GIRDER SECTION

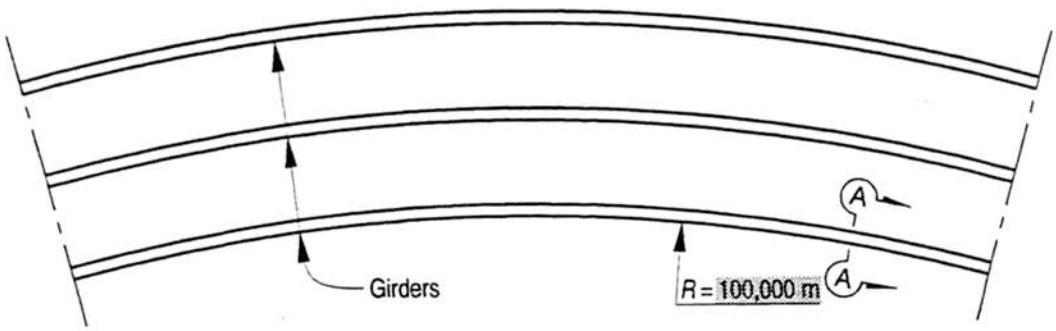
Detail "A"

Use of Detail "A" will require an adjustment of the basic prestressing steel path ordinates used for design. See Memo to Designers 11-28.

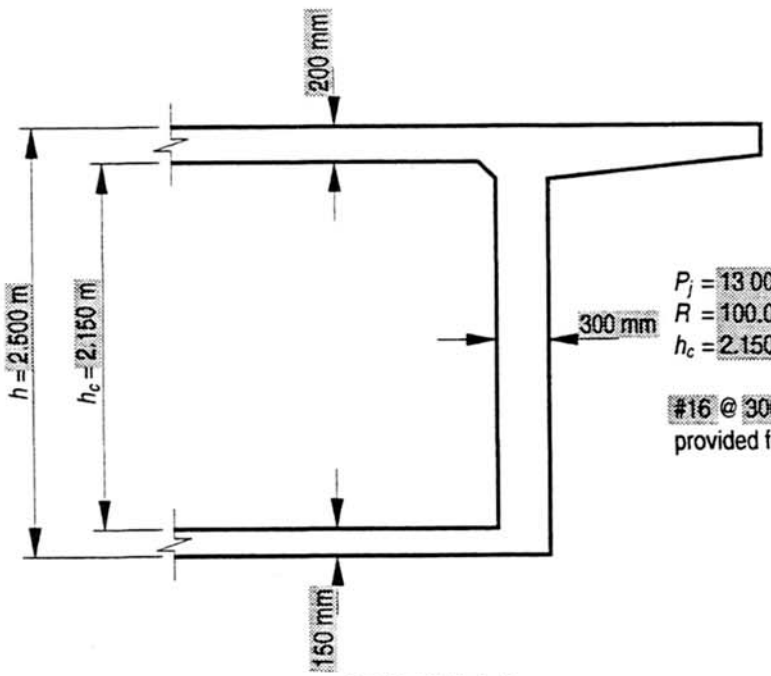

#16 Stirrups
@150
@200
@225
@300
@375
@450
@600
375 mm
350 mm
325 mm
300 mm
Required web thickness
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
0
F= Pj/R (kN per m per girder)
2.75
2.50
2.25
2.00
1.75
1.50
1.25
1.00
Hc (m)
hc


#19 Stirrups
@225
@300
@375
@475
@600
375 mm
350 mm
325 mm
300 mm
Required web thickness
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
0
F= P/R (kN per m per girder)
2.75
2.50
2.25
2.00
1.75
1.50
1.25
1.00
Hc (m)
hc

Example



PLAN



SECTION A-A

$$F = P_j/R = 13\,000/100 = 130 \text{ kN per m}$$

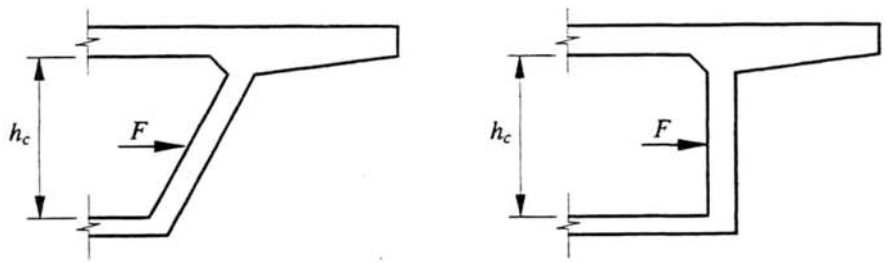
From the graph for #16 Stirrups, F = 130 and h_c = 2.150 — decrease maximum stirrup spacing from 300 mm to 220 mm.

Commentary

The following assumptions were made in the development of this Memo to Designers:

Bending Moment

The girder web is assumed to be a beam with a length equal to the clear distance between top and bottom slabs (h_c). The lateral prestress force (F) is acting at the center point of the web ($h_c/2$). The moment is calculated by simple beam formula reduced 20% for continuity between web and slabs with 1.0 load factor applied.



$$M_u = (1.0)(0.8)(1/4)(P_j/R)(h_c) = 0.20\ (F)\ h_c$$

The shear and bending stresses in the girder stirrups are additive. For the purposes of this memo, however, stirrups are considered capable of handling these stresses independently for the following reasons:

- M_u is calculated for the maximum condition of F acting at $h_c/2$. This occurs at only two points in a span due to tendon drape.
- The jacking force, P_j, is used in the calculation of M_u, and at the time P_j is applied, the structures is supported on falsework. When the falsework is removed and vertical shear forces act, the prestressing force has been reduced by losses.

Richard D. Land

Shannon H. Post

EKT/FH:jlw